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Device for the Separation of Volatile Organic Carbon Compounds from a Carrier Liquid

The invention relates to a device for the separation of volatile organic carbon compounds (VOC) from a carrier liquid, especially water, as defined in the generic clause of Claim 1.

Carbon compounds are divided into two groups, organic and inorganic. In contrast to inorganic carbon compounds, thousands of organic compounds are known. Depending on type, these can be hazardous to humans as well as to the environment. For that reason, the measurement and monitoring of organically bound carbon is essential.

The determination can be carried out on a single substance or as a carbon count. For the monitoring of liquids such as industrial waste water or cooling water, determination occurs in two steps: a tedious and time intensive analysis of single substances is only executed after an established limit of the sum of organically bound carbon is exceeded. For that reason, there is a necessity for a fast and simple measuring device for the measurement of the total organic carbon (TOC).

A total organic carbon measuring analyzer that measures volatile organic carbon (VOC) in water is disclosed in the publication YOKOGAWA Technical Report English Edition, No.31 (2001), pages 1 to 4 of the company Yokogawa Electric Corporation. For this purpose, the VOC components are separated from the water with a generic device. The separating device consists of a container in which the liquid is present

and through which clean air, acting as measuring gas, is continuously streamed. During this process the measuring gas is saturated with the volatile constituents of the organically bound carbon. Devices of this kind are also known as stripping devices or strippers. Since the measuring gas not only takes up VOC components, but is also saturated with water, it is fed to a dehumidifier before it is analyzed. The gas is then transported by an external pump into a total carbon gas analyzer, by means of which the measurement of the VOC constituents is carried out. Such gas analyzers may contain various forms of VOC-sensitive detectors, for example flame ionization detectors, photometric ionization detectors, semiconductor ionization detectors, and other detectors. Instead of using a dehumidifier, the piping that transports the saturated measuring gas can simply be heated.

On the basis of this prior art, the object of the invention is to provide a device that functions in the most simple way possible, that is accordingly easy to maintain and cost effective, and that allows for quick and simple measurement of total organic carbon.

This problem is solved by a device having the features defined in Claim 1.

A device of the invention for the separation of volatile organic carbon from a carrier liquid, especially water, comprises a separating container having a carrier liquid inlet, a measuring gas inlet line, a carrier liquid drain, and a measuring gas flue, wherein the carrier liquid outlet contains a dynamic pressure system that ensures that the pressure in the measuring gas flue is constant.

The dynamic pressure system ensures constant pressure in the carrier liquid flue, so that the measuring gas can be passed to the downstream analyzing device without the use of an external pump. Not only can cost be saved by dispensing with an external pump, but this also substantially simplifies the whole setup and reduces maintenance requirements.

A dynamic pressure of 4 kPa has been found to be advantageous.

The dynamic pressure system is advantageously embodied as a back pressure ves-

sel to provide a simple construction.

In order to attain a reproducible and long-term stable phase transformation, not only the pressure but also the temperature of the carrier liquid is kept constant. To this end, the carrier liquid inlet is furnished with a preheating unit. Furthermore, the air throughput can be held constant by means of a pressure controller and a throttle.

Air is preferred as the measuring gas.

The measuring gas flue contains a cooling unit to cool the measuring gas therein, so that no undesirable condensation takes place in the measuring gas pipe extending between the device of the invention and the downstream analyzer. Any additional heating device for heating the pipe to avoid condensation therein, as is usually necessary, is no longer required.

The cooling unit is set up above the separating container and/or the back pressure vessel, so that the condensate produced in the cooling unit cannot interfere with the measuring process and flows back into the carrier liquid and is discharged with it. Thus the cooling unit drains continuously without any maintenance. To this end, the measuring gas is caused to flow in at the bottom of the cooling unit and to flow out at the top thereof, so that the condensate can run back through the measuring gas inlet.

The cooling unit is advantageously embodied as a Peltier cooler.

It is advantageous to cool the measuring gas in the unit to about 2°C, since the dew points of the volatile organic substances are often less than 2°C, and therefore these substances remain in a gaseous state, whereas the carrier liquid, such as water, will be condensed.

The invention is described below in detail with reference to an exemplary embodiment illustrated in the drawings, in which:

Fig. 1 is a block diagram of the device of the invention;

Fig. 2 is a diagrammatical illustration of a measuring gas cooler of an arrangement as per Fig.1 shown as a cross section taken along the line II-II in Fig. 3;

Fig. 3 is a diagrammatical illustration of a measuring gas cooler shown as a cross section taken on the line III-III in Fig. 2.

A device 10 of the invention as depicted in Fig. 1 for the separation of volatile organic carbon compounds (referred to below as VOC) from a carrier liquid, which is water in the present embodiment, comprises a separating container 12, through which water continuously streams, and also through which, simultaneously, the measuring gas flows. In this exemplary embodiment, air is used as the measuring gas.

The water flows through the inlet 14 into the separating container 12, and is discharged through the drain 16 out of the separating container 12, the inlet 14 being disposed at a lower level and the outlet 16 at a higher level.

The air is drawn through the water via a measuring gas inlet 18, also disposed at a lower level, and a measuring gas flue 20 disposed at a higher level, the air traveling upwardly through the water in the form of air bubbles which accumulate VOC components and also water vapor.

A preheating unit 22 is provided in the water inlet line, in which a heating device 24 keeps the water at a constant temperature, which for example might range from 40 to 80°C. A constant temperature provides the desired reproducibility and long term stability.

A dynamic pressure system in the form of a back pressure vessel 26 is disposed in the water drain. The purpose of this vessel is to maintain a constant pressure of the gaseous phase in the separating container 12 and the measuring gas flue 20, such pressure being preferably kept at 4 kPa. Due to this constant excess pressure in the gas flue, the air can be drawn from the system 10 of the invention to an analyzer (not shown) that will measure the VOC content of the gas, without having to use an external pump. In the present exemplary embodiment, the back pressure vessel 26 is

simply embodied as an inner pipe 28 and an outer pipe 30, wherein the level of the water outlet 32 of the outer pipe 30 determines the dynamic pressure.

For reasons of reproducibility and long term stability the air throughput can be regulated with the aid of a pressure controller 34 and a throttle 36 located in the gas inlet 18.

Within the gas flue 20 there is disposed a cooling unit 38, through which the measurement gas flows and in which the gas is cooled to a temperature at which the water unavoidably collected by the air in the separating container 12 is condensed.

The cooling unit 38 is placed above the separating container 12 and/or the back pressure vessel 26, so that the condensation liquid formed in the cooling unit 38 flows back into the carrier liquid and is discharged with it through the outlet 16.

In Figs. 2 and 3, a possible design of the cooling unit 38 is illustrated diagrammatically. The cooling unit 38 is embodied as a heat exchanger and exhibits a bottom inlet 40 for the measuring gas and a top flue 42. The water of condensation can flow back into the separating container 12 or the back pressure vessel 26 through the bottom measuring gas inlet 40.

The measuring gas flows into individual channels 44 of the cooling unit 38 and is cooled down to a preferred 2°C by heat exchange with the cooled fins 46 and the wall 48. The cooling unit 38 is preferably embodied as a Peltier cooler. The cooling fins 46 are oriented vertically, so that no water of condensation remains in the cooling unit and substantially all condensate drains away. The cooling fins 46 may, if desired, have a favorable aerodynamic shape such that no large pressure drop occurs in the cooling unit 38.